APPENDIX A
ANNUAL TREND ANALYSIS AND GRAPHS

In this Section, monitoring data for a number of pollutants are aggregated on an annual basis and plotted against time to indicate long-term trends. A trend is a broad long-term movement in the time sequence of air quality measurements.

Comparable data on several factors known to influence air quality are also plotted for ease of comparison. Some caution in making comparisons is urged however, because the nature and strength of the causal relationships, if any, are somewhat speculative.

A1. PARTICULATE MATTER (PM_{10})

Particulate matter (PM_{10}) is emitted directly by mobile and industrial sources or is formed in the atmosphere by reaction with sulfur dioxide, nitrogen oxides, and volatile organic compounds.

In the Group A graphs, the composite average annual arithmetic mean PM_{10} concentrations are compared with traffic, building activity and rainfall deficit. There has been a significant long-term downward trend in the PM_{10} composite average
(-36.4%) since 1987. The 1-year change between 1998 and 1999 was -1.9 percent. The building activity graph reflects residential projects under construction during January of each year, and is used as an indicator of development activities, i.e. fugitive dust emissions, for the succeeding year. The traffic graph is used as an indicator of vehicle travel growth as measured by vehicle miles traveled. The rainfall deficit graph is a plot of the percentage difference above or below normal. Rainfall deficit is plotted with "below normal rainfall" as a positive percentage for ease of comparison with the PM_{10} graph.

Vehicle travel growth and development activities have the effect of increasing the amount of dust in the air. Pollution emissions from automobiles are declining despite increases in vehicle miles traveled each year. Building activity declined 78.6 percent between 1986 and 1991, and has increased 84.8 percent from 1991 to 1999. PM_{10} levels continued to fall between 1991 and 1999 (26.9%) despite an increase in building activity. PM_{10} trends are highly associated with the trends in sulfur dioxide and nitrogen oxides. PM_{10} levels seem to be affected more by reductions in sulfur dioxide, nitrogen oxides, and volatile organic compound emissions than by increases in building activity or the growth in vehicle travel. Rainfall has the effect of minimizing dust re-entrainment and also cleans dust out of the air. PM_{10} levels, on an annual basis, seem to be unaffected by the amount of rainfall in a given year.

A2. OZONE

Ozone levels tend to be high during the warm months of the year. The official "Ozone Season" for the Metropolitan Washington area begins in April and continues through October of each year. In the top left graph of Group B-1, ozone levels are expressed in terms of the composite average (four sites) of the second highest daily maximum 1-hour concentration. The composite average tends to vary from year to year due to a number of different factors affecting ozone levels, such as changing meteorological conditions and precursor emission changes. The long-term mean of the composite average since 1974 is 0.13 ppm. In 1983 Fairfax County exceeded the standard (0.12 ppm) on 25 days, in 1987 on 15 days, and in 1988 on 22 days. The composite average in 1983 was 15 percent above it's long-term mean, in 1987 it was 8 percent above it's long-term mean, and in 1988 it was 22 percent above it's long-term mean. There were many hot clear days during the ozone seasons of 1983, 1987, and 1988, conditions very conducive to ozone formation.

In 1992, 1996, and 1997 the composite average was 18, 18.5, and 19.2 percent below it's long-term mean. Cooler than normal temperatures persisted during most of these ozone seasons, as well as above normal cloud cover. These cool and/or cloudy conditions are not conducive to ozone formation. Ozone levels during the 1996 and 1997 ozone seasons were the lowest measured since 1974 when monitoring began. Ozone levels during the 1999 ozone season were lower than 1998. The composite average (0.116 ppm) increased 9.4 percent above the 1996 and 1997 levels, and was 10.8 percent below the long-term mean. There has been a downward trend in the composite average, -14.1 percent, since 1979.

The top right graph of Group B-1 depicts the number of "unhealthful" days as defined by the Air Quality Index (AQI). The AQI is the national uniform index system, the use of which in this area is required by Federal regulation. (See section E.1. Air Quality Index for more information). For purposes of this report, an "unhealthful" day is defined as any day when the measurement at any Fairfax County station yields an index value greater than 100. In 1983 Fairfax County experienced 30 "unhealthful" days, in 1987 17 "unhealthful" days, and in 1988 28 "unhealthful" days. The large number of "unhealthful" days during these 3 years was due primarily to the occurrence of meteorological conditions very conducive to ozone formation. There were 2 "unhealthful" days in 1999.

The bottom left graph is a plot of the composite average of the average number of exceedant days (an exceedant day is one during which a site had at least one hourly average greater than the ozone standard). The average number of exceedant days is a 3-year running average and is calculated by dividing the total number of exceedant days in a given year plus those in the two prior years by three. The plotted values are a composite of the average number of exceedant days averaged over all the County ozone sites. In 1988 and 1989 the composite average was 7.0 days, the highest value recorded, and reflects the influence of the high number of exceedant days in 1988 on the 3-year averages. The composite averages in 1997 and 1998 were the lowest observed (.58). In 1999, the composite average of exceedant days was 0.75.

On July 18, 1997 EPA promulgated new national ambient air quality standards (NAAQS) for ozone. EPA changed the averaging time to 8 hours and changed the form of the standard from an expected exceedance form to a concentration-based form. The NAAQS for ozone are met at an ambient monitoring site when the 3-year average of the annual fourth highest daily maximum 8-hour concentration is less than or equal to 0.08 ppm. The new standards became effective on September 16, 1997, and the 1-hour standard will remain in effect until EPA determines that this region has attained the 1-hour standard. As stated earlier in this report, (Section C.1. Ozone), a Court opinion was issued on May 14, 1999 regarding the final ambient air quality standards for ozone. Fairfax County continues to monitor for 1-hour and 8-hour ozone standards.

The graphs in Group B-2 will be used to track ozone trends associated with the new 8-hour standards. The statistics used in the plots are directly related to the form and averaging time of the new 8-hour standards. Trends in the composite average of the fourth highest daily maximum 8-hour concentration are shown in the top left graph of Group B-2. There has been a significant downward trend in the composite average, -6.1 percent, since 1979. The composite average was 0.092 ppm in 1999. The top right graph is a plot of the composite average of the 3-year mean fourth highest maximum daily 8-hour concentration and is used to track compliance with the new 8-hour standard. There has been a significant downward trend in the composite average, - 2.2 percent, since 1979. The 1999 composite average of the 3-year mean was 0.091 ppm.

The bottom left graph is a plot of the composite average of the number of days with maximum 8-hour concentration above the 8-hour standard. It shows the year to year variability in the number days the ozone standard was exceeded. The composite average decreased in 1999 to 9 days. The bottom right graph is a plot of the monthly frequency, in percent, of days above the 8-hour standard using all ozone data from 1974 to 1999. April is the earliest month in which the 1-hour standard has been exceeded, while ozone concentrations above the 8-hour standard have been observed in March. July has the greatest number of days above the 8-hour standard. There have been no exceedances of either the 1-hour standard or the 8-hour standard in October.

The graphs in Group B-3 are plots of the maximum daily 8-hour ozone concentration at each ozone monitoring site during the 1999 ozone season. They show the day to day variation in the maximum daily 8-hour mean and the number of exceedances of the 8-hour standard at each site. Mount Vernon exceeded the 8-hour standard on 16 days, Seven Corners on 9 days, and Cub Run and Lewinsville on 6 days.

Ozone in Fairfax County has improved since 1979. Citizens in the County are exposed to fewer unhealthful ozone days and generally lower ozone concentrations on those days.

A3. INDUSTRIAL AND SPACE HEATING EMISSIONS

Sulfur dioxide and nitrogen dioxide trends are shown in Group C along with trends in existing dwelling units and heating degree-days. These pollutants are produced by fossil-fueled space heating and electrical utility boilers as well as by internal combustion engines. In the top left graph the sulfur dioxide levels are expressed in terms of the composite annual average concentration. The composite average decreased 6.6 percent between 1987 and 1999. The sulfur dioxide composite average has shown a long-term downward trend, - 33.6 percent, since 1979.

In the top right graph the nitrogen dioxide levels are expressed in terms of the composite annual average concentration. The composite average decreased 4.2 percent between 1998 and 1999. The nitrogen dioxide composite average has shown a long-term downward trend, - 27.8 percent, since 1979.

The bottom left graph is a plot of the number of dwelling units in Fairfax County. The growth rate in the housing inventory averaged 4.1 percent between 1985 and 1990. The growth rate has slowed to 1.7 percent per year since 1991.

The bottom right graph is a plot of heating demand. Geographical differences in heating demand are substantial, with approximately 730 degree-days average difference between the highest and lowest county stations. Both the age of a community (fossil or electric fuel) and its location (high or low heating demand) influence its emission response to changes in overall heating demand.

A4. LEAD AND VEHICLE EMISSIONS

Carbon monoxide and nitrogen oxides are produced principally by automotive sources and secondarily by fossil fuel space heating. At one time, the primary source of lead in ambient air in this area was the combustion of leaded fuels by automotive vehicles. Group D shows trends of these pollutants along with the traffic trends.

In the top left graph the carbon monoxide levels are expressed in terms of the composite average of the second highest 8-hour average concentration. There has been a long-term downward trend, - 74.1 percent, in the composite average since 1974. Carbon monoxide levels tend to be high during the colder months of the year, January, February, November, and December. High 8-hour average concentrations frequently occur in the 5pm - 1am and 6pm - 2am time frames, and are associated with emission generated by evening rush hour traffic and strong winter temperature inversions. Fairfax County has never exceeded the 1-hour standard and has not violated (2 exceedances in one year) the 8-hour standard since 1979. The last exceedance of the 8-hour standard was in 1986. Fairfax County is in attainment for the NAAQS for carbon monoxide.

In the top right graph of Group D, lead levels are expressed in terms of the composite average of the maximum quarterly average concentration. There has been a long-term decrease of 96 percent in lead levels since 1981. The 1999 composite average is 1.0 percent of the National Standard of I.5 $\mu g/M^3$. This decrease in the composite average can be attributed to the Environmental Protection Agency's (EPA) program of eliminating lead in gasoline. The EPA lowered the allowable lead content in gasoline by 50 percent on July 1, 1985. A further reduction to 0.1 grams/gal, a 90% reduction from pre-July 1985 levels, was implemented on January 1, 1986. In 1975 unleaded gasoline was introduced, which now accounts for about 99% of gasoline sales.

In the bottom left graph oxides of nitrogen levels are expressed in terms of the composite average of the annual average concentration. The annual average is calculated as the sum of the annual averages of nitrogen dioxide and nitrogen oxide. There has been a downward trend in the composite average, - 36.8 percent, since 1979.

In the bottom right graph the number of vehicle miles traveled in the County each year is plotted. Despite increases in the number of vehicle miles traveled pollutant emissions from motor vehicles have continued to decline. Additional emission control strategies will be needed in the future if declines in motor vehicle emissions are offset by continued growth in the number of vehicle miles traveled.

A5. ACID DEPOSITION

Sulfuric and nitric acids are the two major components of both wet and dry acidic deposition. The top left and top right graphs in Group E show trends in their precursors, sulfur dioxide and nitric oxides. Sulfur dioxide reacts with hydroxyl radicals, hydrogen peroxide and ozone, to produce sulfate ions. Nitric oxide reacts with a number of different pollutants such as hydrocarbons, carbon monoxide, hydroperoxyl radicals, hydroxyl radicals, and ozone to produce nitric acid, particulate nitrate, and peroxyacetyl nitrate (PAN). The bottom left and bottom right graphs show trends in rainfall and volume weighted pH at the Occoquan Hill site. There is evidence of a downward trend in pH at Occoquan Hill; the long-term average is 4.20. The average pH from 1989 to 1996 was 4.27, and from 1997 to 1999 it was 4.00.

A6. WEATHER

Meteorological monitoring was initiated in 1974 for wind direction and wind speed, temperature, and rainfall. Group F shows trends of rainfall, temperature, heating demand, and cooling demand.

The top left graph in Group F illustrates the year to year variability inherent in rainfall. The values used in this graph are obtained as follows: the observed rainfall amounts at all County stations, plus Dulles, National, and Davison airports for each month and for each year are averaged to obtain a composite county average amount, for the year of interest. The long-term average uses the climatological values from the three airports. Annual rainfall in 1999 was 41.58 inches, 0.94 inches above normal. Annual rainfall in 1996 was 55.82 inches, the wettest year since 1974. The driest year was in 1980, 29.94 inches of rainfall, 10.84 inches below normal.

The top right graph is a plot of the annual mean temperature. The warmest annual mean temperature was set in 1998 (59.1°F). The United States average temperature in 1998 was also one of the warmest years on record. The coolest annual mean temperature observed in the County was in 1978 (53.0°F). The annual mean temperature in 1999 was 57.5°F. There has been an upward trend in the annual mean temperature in the County since monitoring was initiated in 1974. Several factors have probably influenced the apparent trend in the annual mean temperature, improvements in the temperature measurement instrumentation, changes in sample site location, and a "heat island" effect. Fairfax County has become increasingly developed over the last twenty years. There are more buildings and streets, which can collect, heat during the day and hold on to it longer at night, increasing the temperature of the surrounding air.

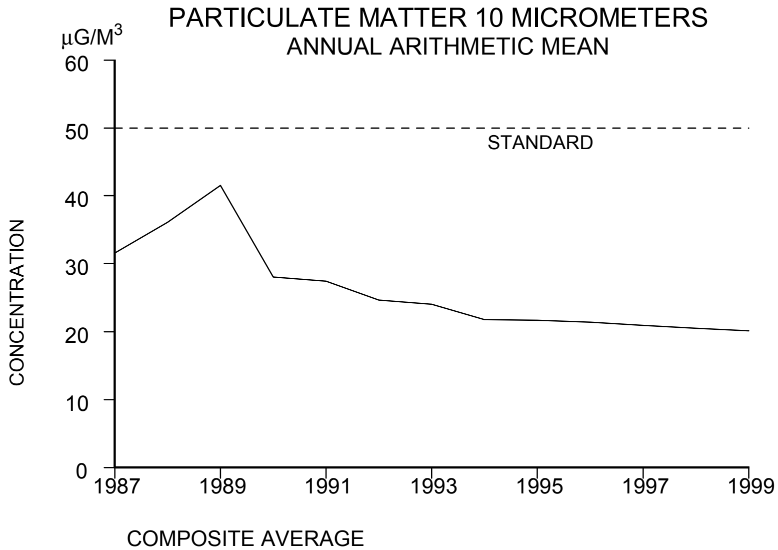
The bottom left graph is a plot of the County average heating demand. Heating degree-days are used as a rough indicator of the heating demand, the amount of fuel consumed in space heating. One heating degree-day is given for each degree the daily mean temperature falls below 65°F. The heating degree-days are totaled over a heating season and averaged over all County monitoring sites. There has been a long-term downward trend in heating demand since 1978.

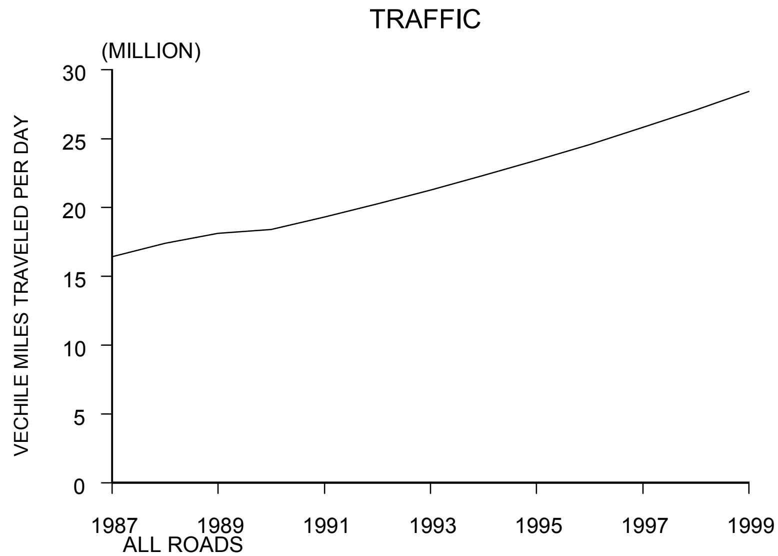
The bottom right graph is a plot of the County average cooling demand. Cooling degree-days are used as a rough estimate of the energy requirements for refrigeration and air conditioning. One cooling degree-day is given for each degree the daily mean temperature rises above 65°F. The cooling degree-days are totaled over the cooling season and averaged over all County monitoring sites. There is no evidence for a trend in the cooling demand.

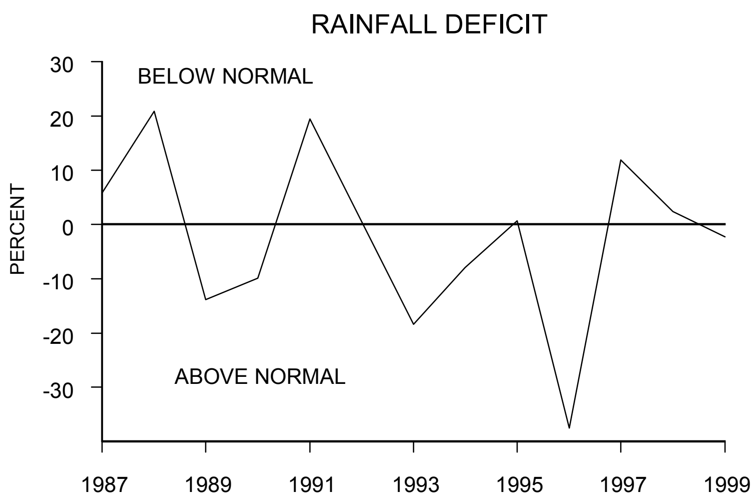
The predominant wind directions in the summer months are from the southwest quadrant. In the winter and late fall the predominant winds are from the northwest quadrant. Higher mean wind speeds are associated with winds from the northwest quadrant.

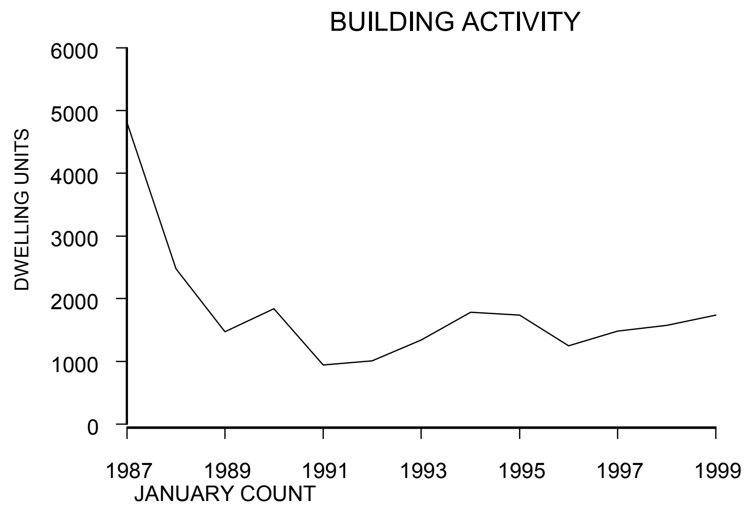
ANNUAL TRENDS

GROUP A



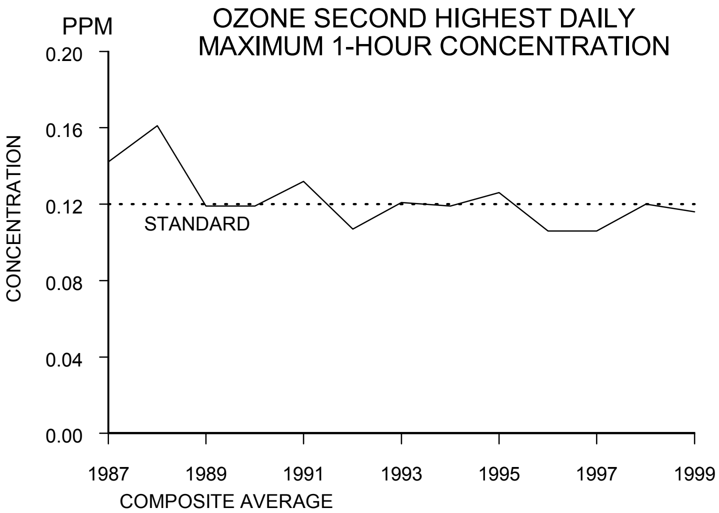


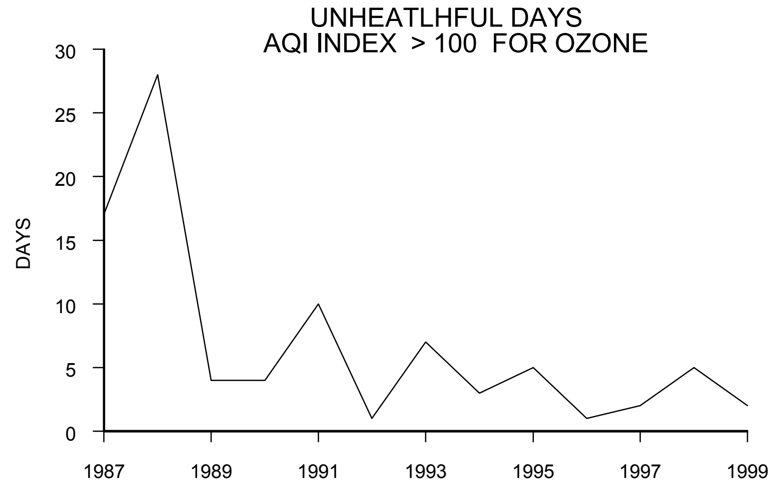


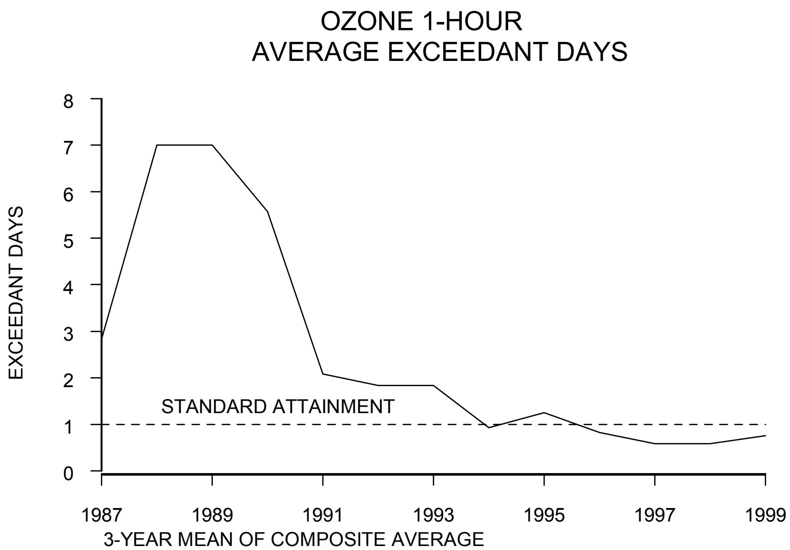


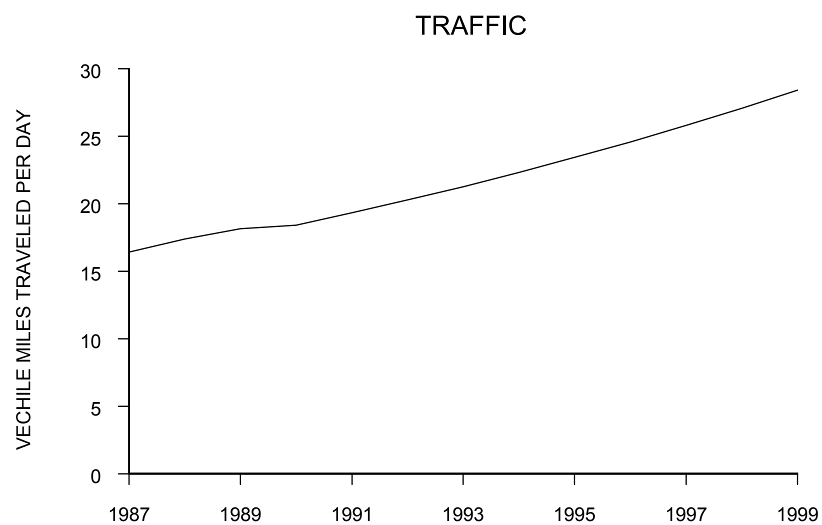
ANNUAL TRENDS

GROUP B-1



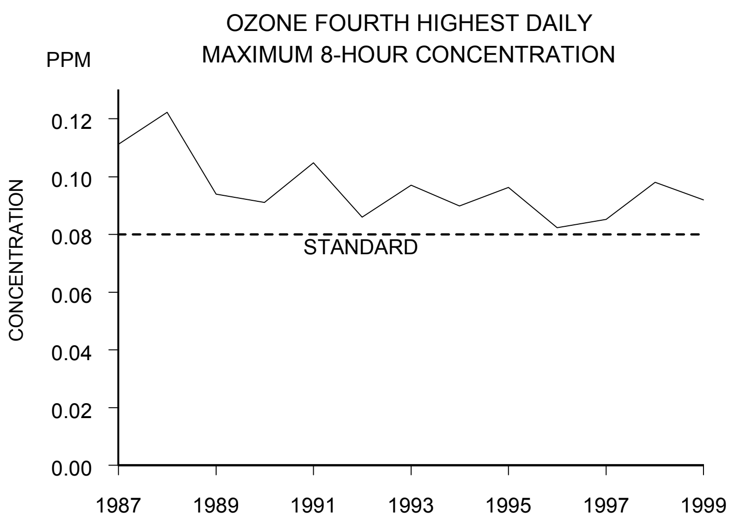


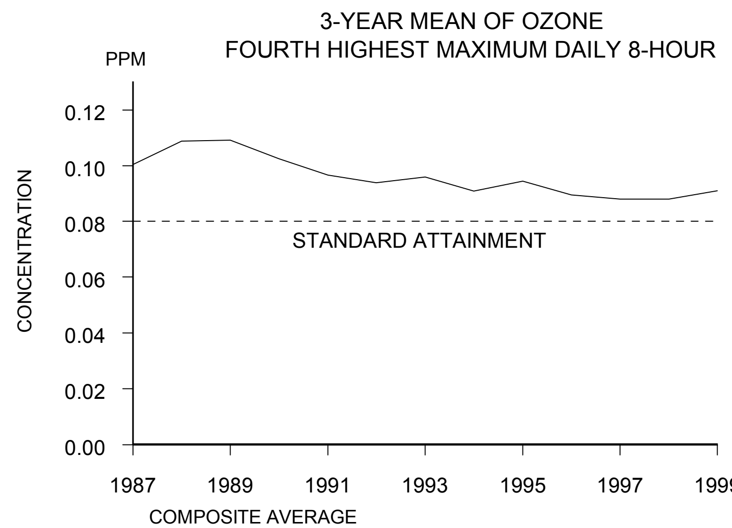


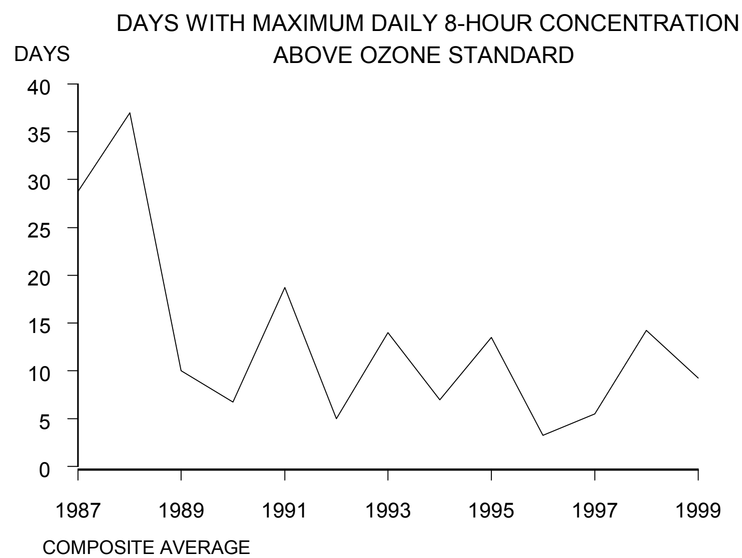


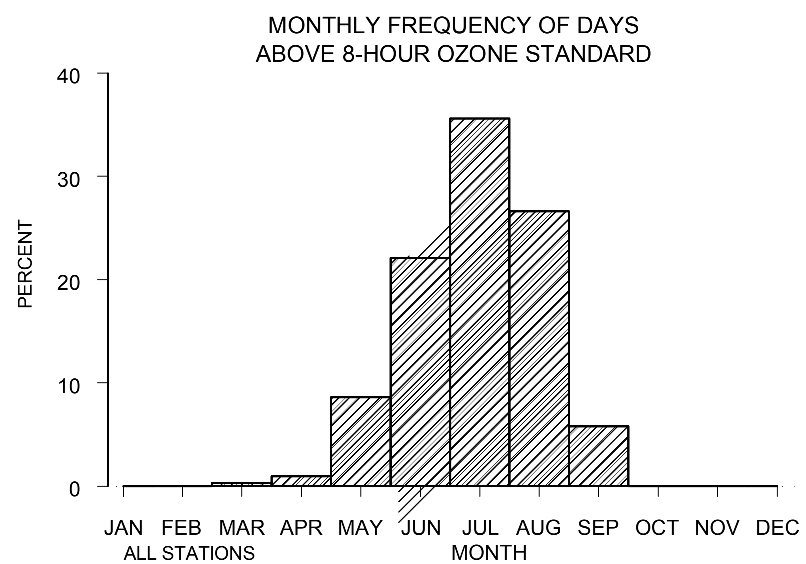
ANNUAL TRENDS

GROUP B-2





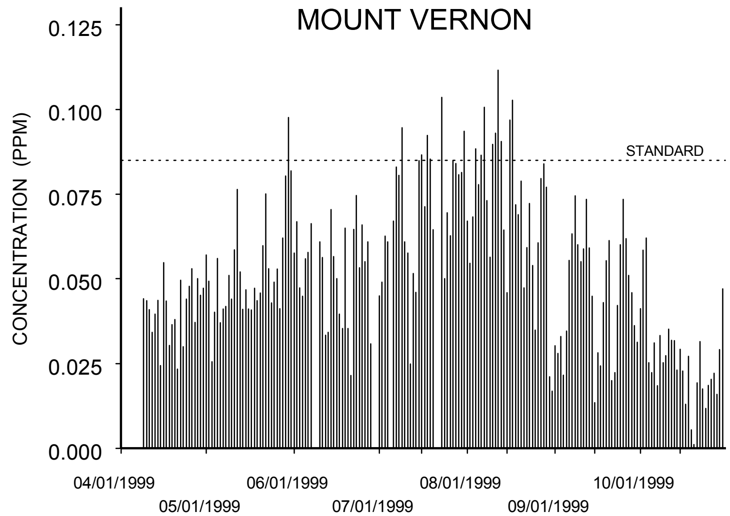


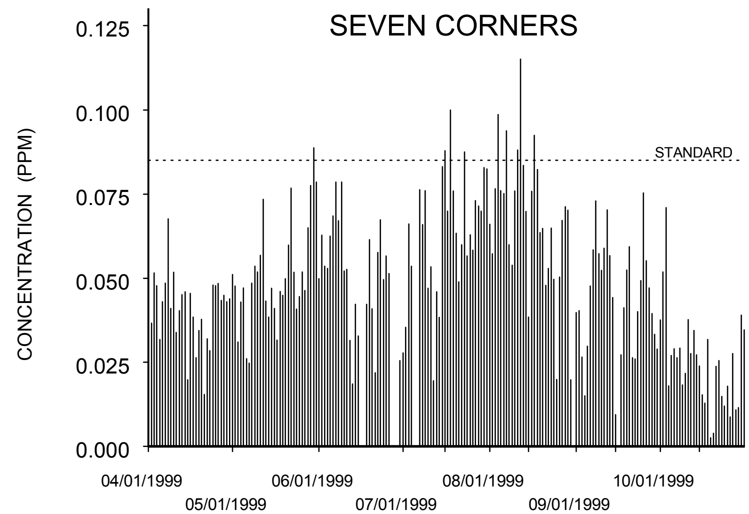


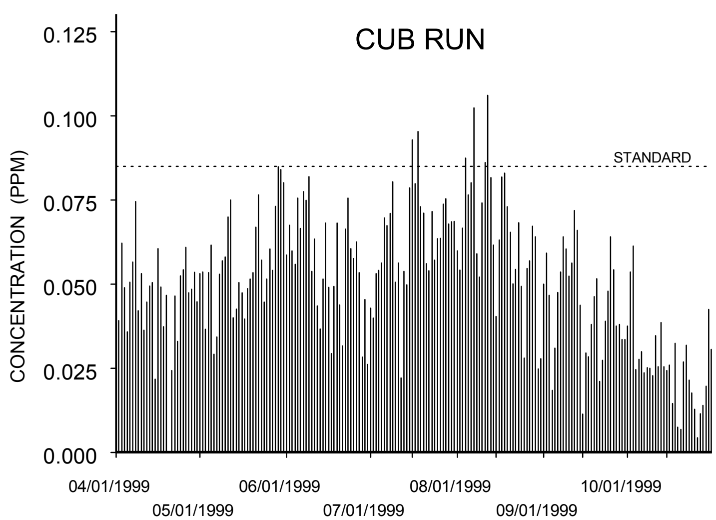
ANNUAL TRENDS

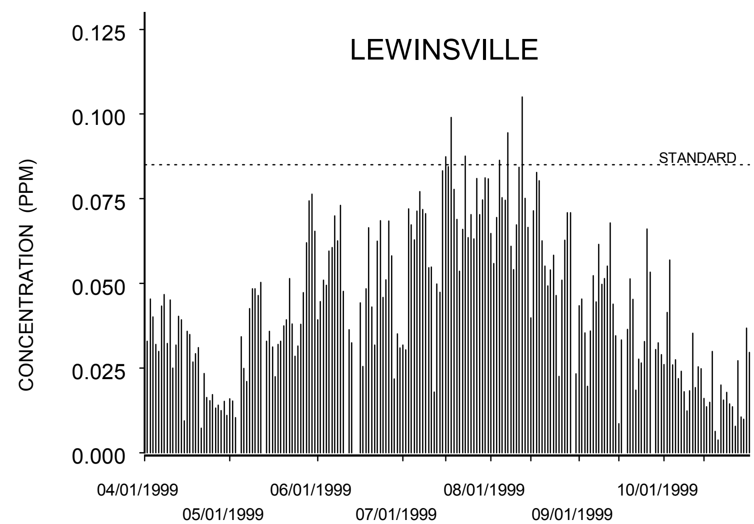
GROUP B-3

MAXIMUM DAILY 8-HOUR OZONE CONCENTRATION



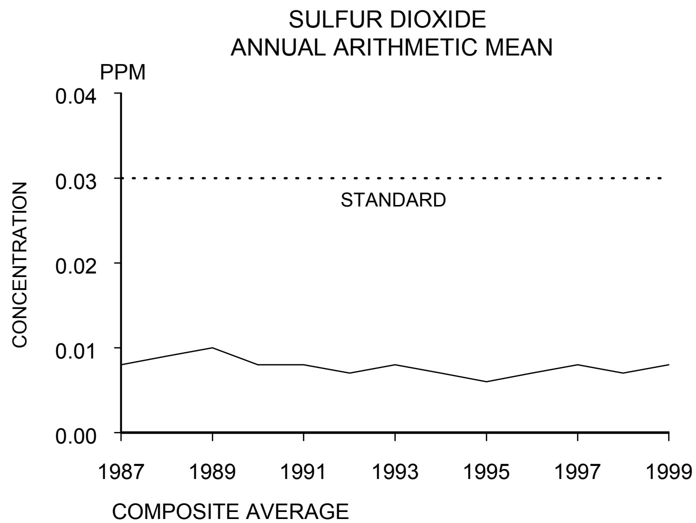


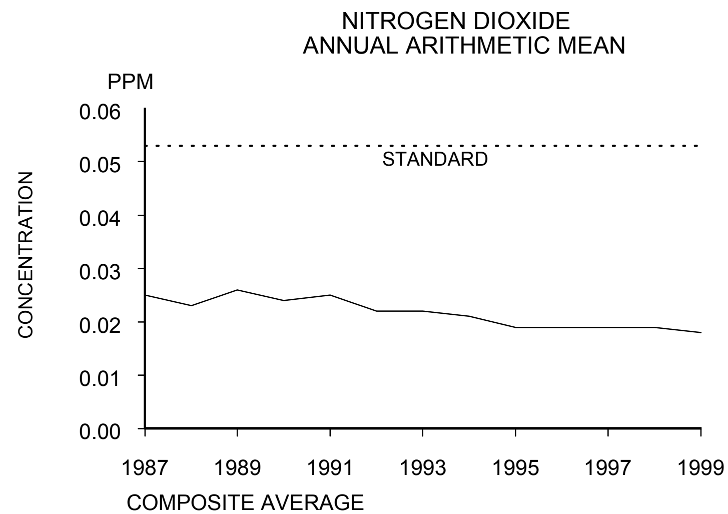


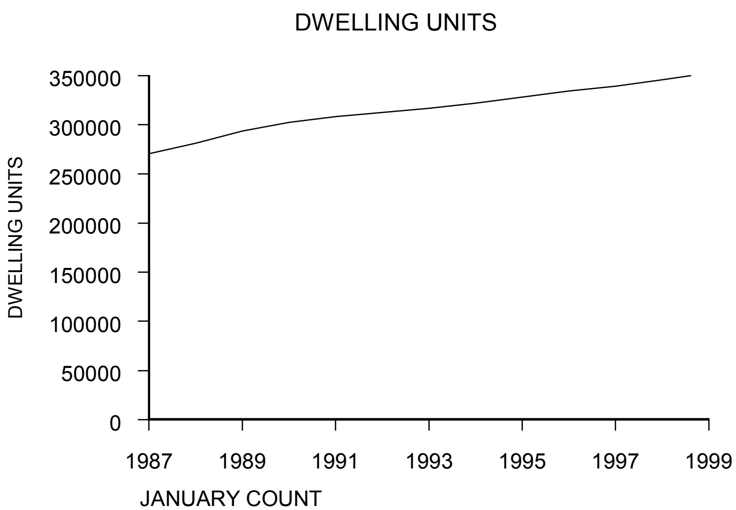


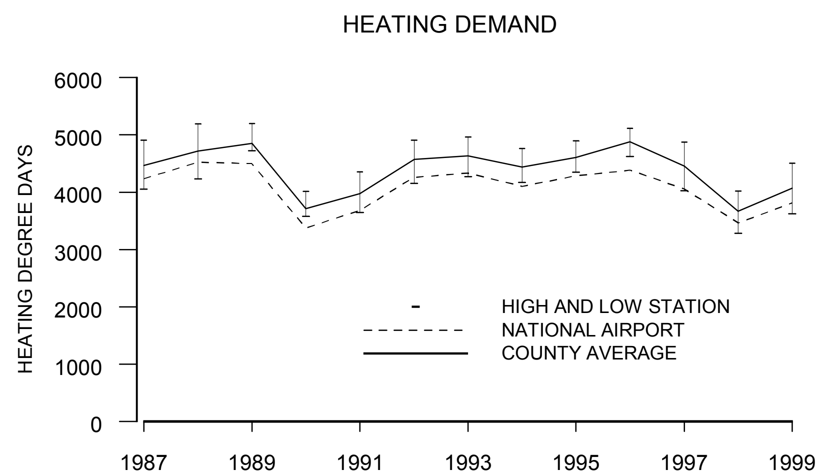
ANNUAL TRENDS

GROUP C









ANNUAL TRENDS

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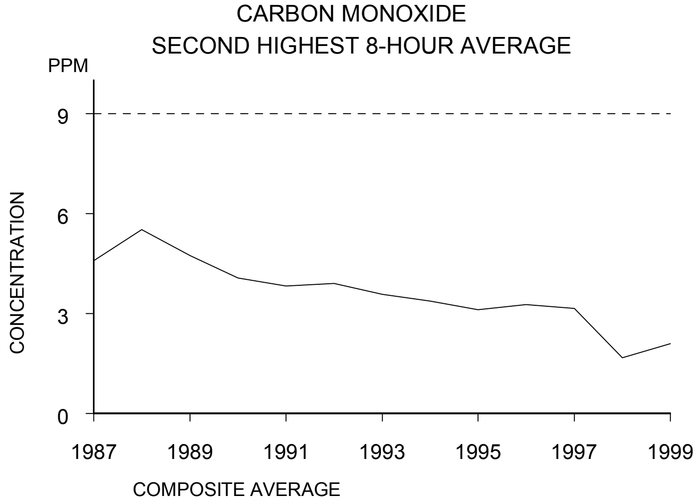
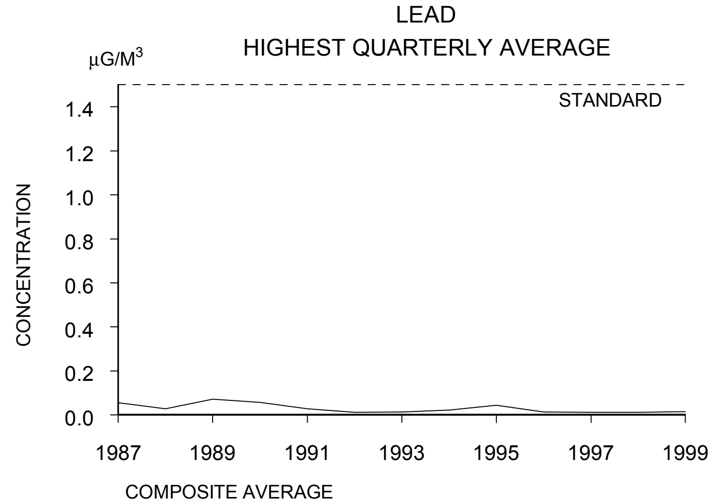
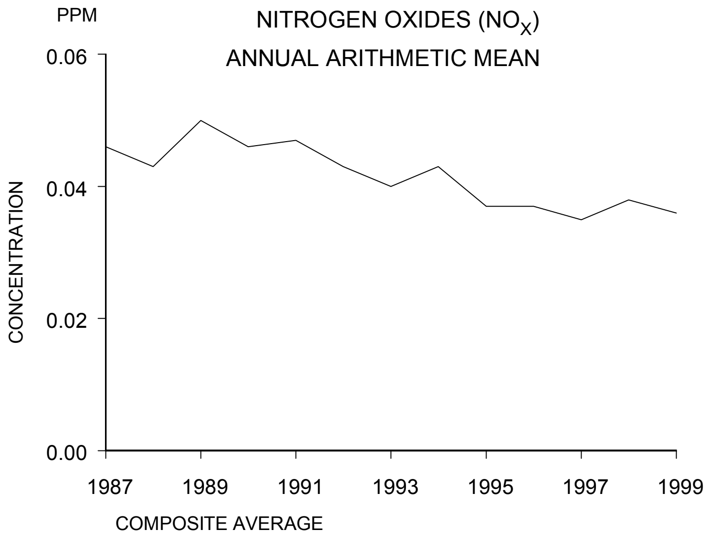
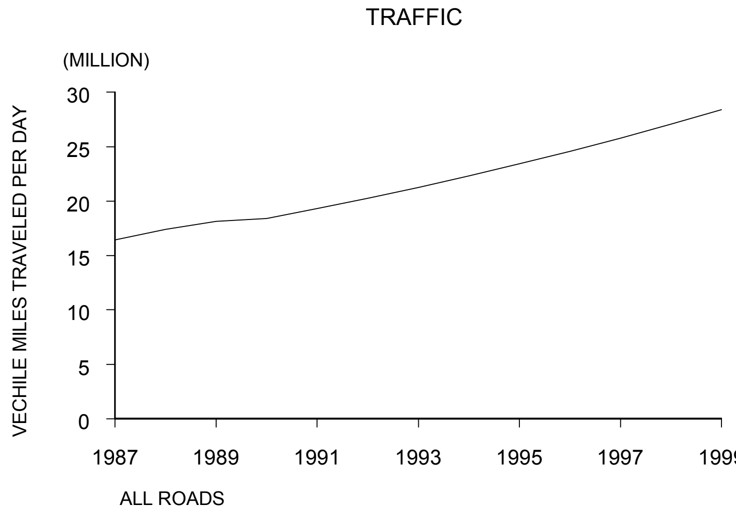


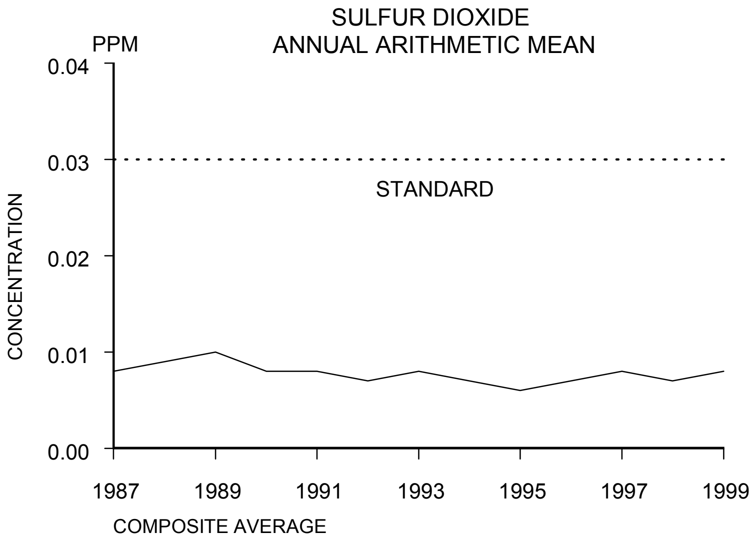


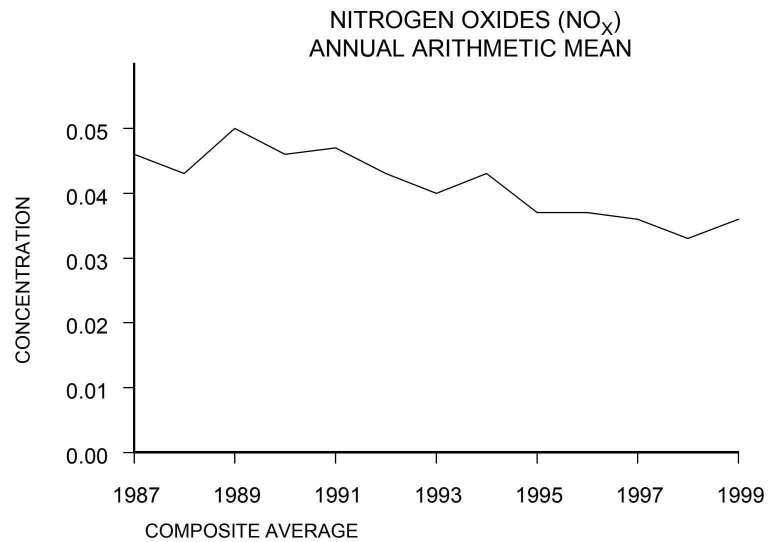


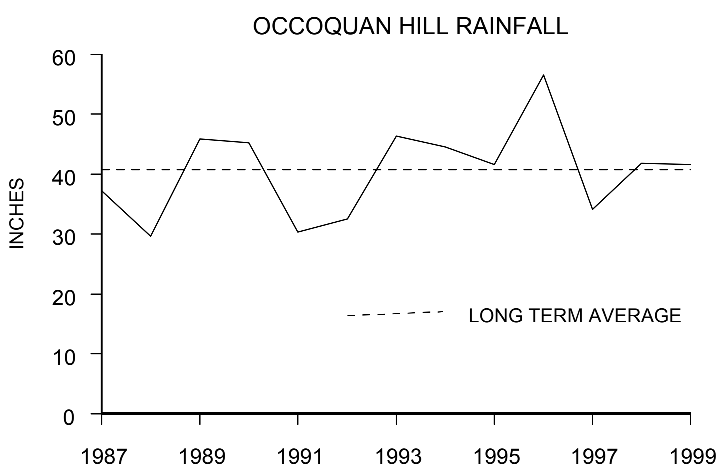


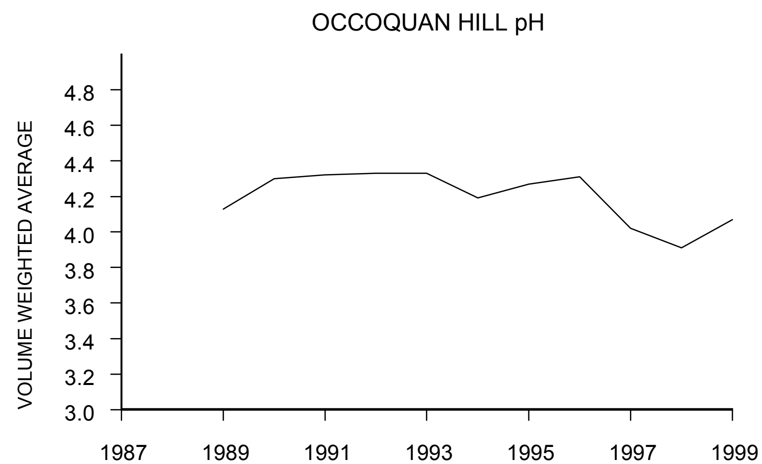
ANNUAL TRENDS

GROUP E



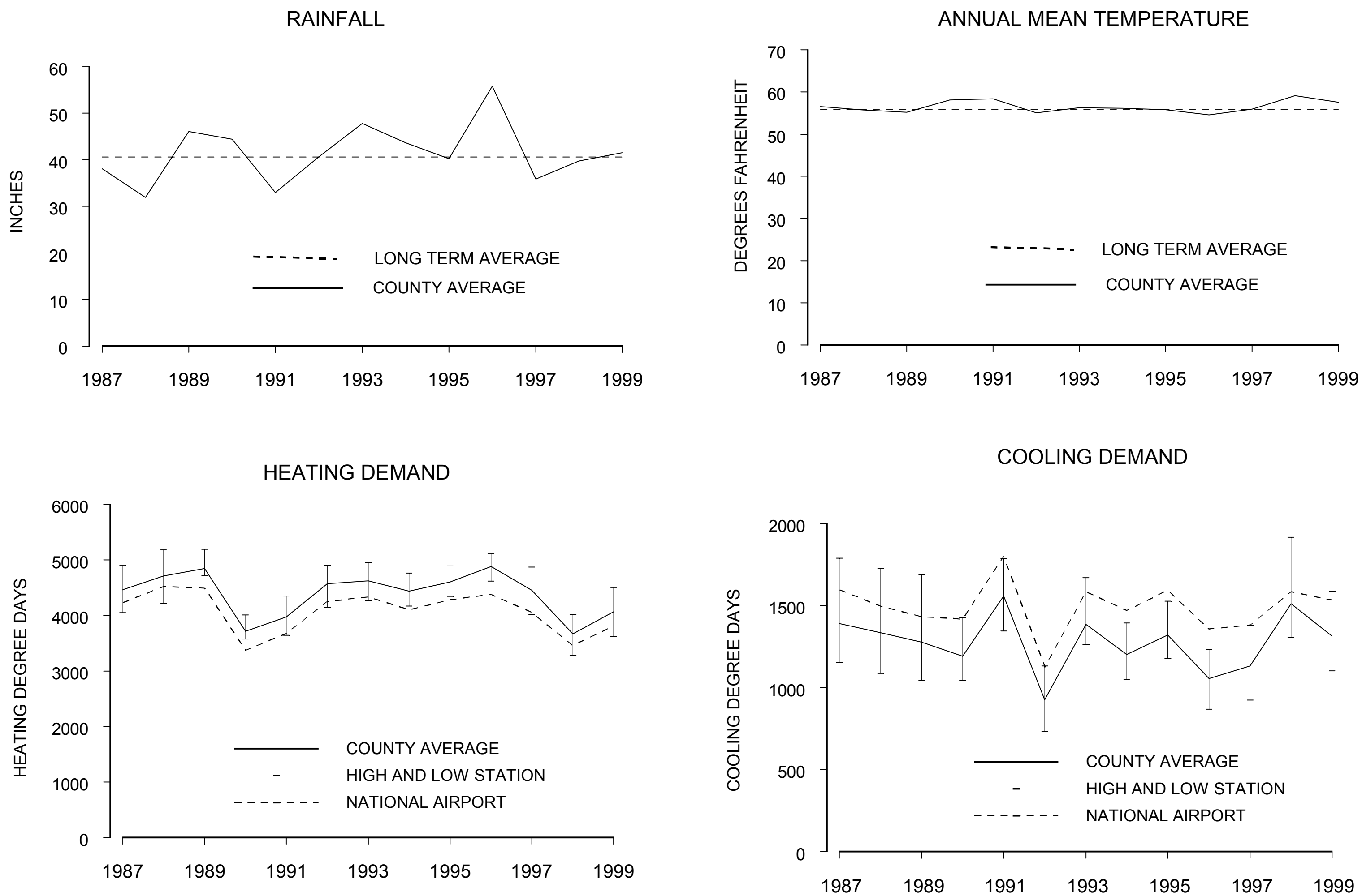






ANNUAL TRENDS

GROUP F



APPENDIX B
MONITORING SITES AND MAP

SITE	ADDRESS	LATITUDE	LONGITUDE	UTM COORDINATES	TAX MAP	AIR POLLUTANT PARAMETERS	METEOROLOGICAL PARAMETERS
CUB RUN AIRS: 51-059-0005	Upper Cub Run Dr. Chantilly	38° 53' 38.3" N	77° 27' 56.3" W	289.177 km E, 4307.697 km N	33-4	CO; O3; NO/NO2; SO2; PM10	None
FRANCONIA AIRS: 51-059-0030	6601 Telegraph Rd. Franconia	38° 46' 22" N	77° 06' 20" W	317.090 km, 4293.450 km N	92-1	O3; O3	None
LEWINSVILLE AIRS: 51-059-5001	1437 Balls Hill Rd. Mclean	38° 55' 56.6" N	77° 11' 54.6" W	309.443 km E, 4311.600 km N	30-1	CO; O3; NO/NO2; SO2; PM2.5	Wind Speed and Direction; Temperature, Precipitation
MOUNT VERNON AIRS: 51-059-0018	2675 Sherwood Hall Ln. Mount Vernon	38° 44' 32" N	77° 04' 37" W	319.488 km E, 4290.214 km N	102-1	O3; PM10	Wind Speed and Direction; Temperature; Precipitation
SEVEN CORNERS AIRS: 51-059-1004	6100 Arlington Blvd. Falls Church	38° 52' 05.4" N	77° 08' 34.91" W	314.073 km E, 4304.095 km N	51-4	CO; O3; NO/NO2; PM2.5	Wind Speed and Direction; Temperature; Precipitation
BUSH HILL*	5927 Westchester St. Alexandria	38° 47' 24" N	77° 07' 25" W	315.46 km E 4295.400 km N	81-4	TSP; Lead	None
CLERMONT*	5720 Clermont Dr. Alexandria	38° 47' 42" N	77° 06' 42" W	316.505 km E, 4295.963 km N	82-1	TSP; Lead	None
GUNSTON* AIRS: 51-059-0021	10100 Gunston Rd. Lorton	38° 41' 03" N	77° 12' 35" W	307.369 km E, 4283.938 km N	113-2	TSP; Lead	None
I-95* AIRS: 51-059-0029	9850 Furnace Rd. Lorton	38° 41' 30.5" N	77° 14' 41.5" W	305.280 km E, 4284.740 km N	113-1	TSP; Lead	None
LUCK* AIRS: 51-059-0123	15500 Lee Hwy. Centreville	38° 49' 16.0" N	77° 27' 05.5" W	284.310 km E, 4300.512 km N	64-1	None	Wind Speed and Direction; Temperature; Precipitation
OCCOQUAN HILL* AIRS: 51-059-0023	9900 Ox Rd. Lorton	38° 41' 23.8" N	77° 15' 34.7 W	303.475 km E, 4284.648 km N	112-2	TSP; PM10; Lead	Wind Speed and Direction; Temperature; Precipitation
SPRINGFIELD AIRS: 51-059-3002	6120 Brandon Ave. Springfield	38° 47' 03" N	77° 10' 57.0" W	310.420 km E, 4294.805 km N	80-4	TSP; PM10; Lead	None
THOMAS EDISON*	5801 Franconia Rd. Alexandria	38° 46' 55" N	77° 08' 00" W	314.500 km E, 4294.56 km N	81-4	TSP; Lead	None

*Special study monitoring site; may not have assigned AIRS number.